D3 Cancel 16. (New Claim) A semiconductor device according to claim 8, wherein said hole is located to surround said protrusion.--

REMARKS

The final Office Action mailed October 9, 2001, the Advisory Action mailed April 5, 2002, and the references cited therein have been carefully considered. Claims 1 and 8 have been amended and Claims 15 and 16 have been added to further clarify the distinctions between that which the Applicants regard as the invention and the cited references.

No new matter has been added to the claims, as amended. Support for this Amendment is found generally within the specification, claims, and drawings, as originally filed. Specifically, support for Claims 1 and 8, as amended, and new Claims 15 and 16 is shown in Figures 10, 12, and 13 and described at page 9, line 2 through page 10, line 11 of the specification. As a result of this Amendment taken together with the remarks set forth below, it is respectfully submitted that pending Claims 1-6, 8-13, 15, and 16 are now before the Examiner in condition for favorable consideration and allowance.

Claims 1-6 and 8-13 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,602,423 to Jain (*Jain*) in view of U.S. Patent No. 5,923,088 to Shiue, et al. (*Shiue*). Specifically, the Examiner indicates that *Jain* discloses a damascene interconnection that includes a conductor-filled trench 64 and insulating pillars 50. The Examiner further indicates that Figure 10 shows a plan view of a pillared landing pad 55, through which multiple protrusions are dispersed, and that Figure 6 shows the damascene interconnection formed by a patterned insulating layer 22 over a substrate 20.

In addition, the Examiner states that conducting segments 32, 44, and 46 lie between insulating pillars 38 and that column 5, lines 34-45 indicate that the incorporation of

insulating pillars divides a wider conductor, and thus minimizes dishing. However, the Examiner concedes that *Jain* does not disclose a contact hole formed within the pad trench to electrically connect the conductive film to another conductive film below the insulating film, wherein the contact hole and the additional conductive film substantially suppress an increase in electrical resistance in the pad trench due to formation of the protrusions.

The Examiner indicates that *Shiue* describes a bond pad structure that includes a third metal pad 30, second via plugs 36, and a second metal pad 32 connected to the third metal pad through the second via plugs. The Examiner further indicates that it would have been obvious to one of ordinary skill to include the second via plugs and second metal pad in the invention described in *Jain* to connect the conducting segments to further integration within the substrate.

The subject invention is directed to a damascene interconnection, which includes an interconnection trench, protrusion, conductive film, and contact hole. The interconnection trench is formed is formed in an insulating film and a pad trench communicating therewith. The protrusion is formed by a portion not removed of the insulating film in the pad trench to decrease a substantial opening area of the pad trench.

The conductive film is buried in the interconnection trench and the pad trench. The contact hole is formed within the pad trench at a position near the protrusion and electrically connects the conductive film to a further conductive film formed below the insulating film, wherein the contact hole and the further conductive film substantially suppress an increase in electrical resistance in the pad trench due to formation of the protrusion, as now defined by amended Claim 1.

The subject invention is also directed to a semiconductor device, which includes a semiconductor substrate, insulating film, interconnection trench, pad trench, protrusion, conductive film, further conductive film, and contact hole. The protrusion reduces a

substantial opening area of the pad trench, and the conductive film is buried in the interconnection trench and the pad trench.

The further conductive film is formed below the insulating film. The contact hole is formed within the pad trench at least at a position near the protrusion to electrically connect the conductive film to the further conductive film, wherein the contact hole and the further conductive film substantially suppress an increase in electrical resistance in the pad trench due to formation of the protrusions, as now defined by amended Claim 8.

Jain relates to a semiconductor device that uses an embedded pillar to prevent damage, such as dishing, smearing, and over etching to damascene connectors during fabrication, particularly where such conductors are relatively large. The device includes an insulating layer formed on a substrate having a substantially planar upper surface with a plurality of channels. The channel includes contiguous narrow channel segments enclosing one or more pillars that have a top surface substantially coplanar with the upper surface of the insulating layer. In one embodiment, the pillar is formed integrally as part of the insulating layer.

In an alternative embodiment, the pillar is formed from an additional insulating or conductive layer. However, as indicated by the Examiner *Jain* does not disclose contact holes at the bottom of the conductive film to enable division of the conductive film into non-contiguous portions or areas, as disclosed on page 8, line 23 through page 10, line 11 of the specification and shown in Figures 10-13.

Shiue relates to a bond pad structure that provides for reliable interconnection between a bonding structure and the next level of circuit integration. The bond pad uses three metal pads separated by layers of dielectric, through which via plugs are formed. The periphery of the via plugs form a square rotated 45° with respect to the square metal pads. The second via plugs 36, as shown on Figure 3, are not located above the first via plugs 38,

but are located directly above the spaces between the first via plugs 38. The invention supposedly increases tensile and shear strength to minimize peeling and cracking.

Claims 1 and 8 have been amended to further clarify that the contact hole is formed within the pad trench at a position near the protrusion. This feature advantageously increases uniformity of the resistance across the pad trench 18, which may more clearly be understood by considering the converse. That is, the situation wherein the contact hole is located as far away from the protrusions as possible. In such a case, variation in the resistance across the pad trench is substantially aggravated, rather than being compensated, since the contact hole lowers the resistance in an area of the pad trench that already exhibits a substantially lower resistance than the area corresponding to the protrusions.

In *Shiue*, large portions of the dielectric layers 44, 48, which are completely free of via plugs 36, 38, are shown located at each of four corner regions of the dielectric layers 44, 48 in Figures 4 and 5. The effect on resistance caused by these large portions is entirely uncompensated for by the lack of via plugs 36, 38.

Since the dielectric layers 44, 48 in *Shiue* completely fill the space between via plugs 36, 38, the only way that *Shiue* could teach uniformity of resistance is to locate the via plugs 36, 38 uniformly across the entire dielectric layers 44, 48. However, this is neither taught nor suggested in *Shiue* since the only concern is improving the strength of the bond pad. Thus *Shiue* teaches away from the subject invention by concentrating the via plugs 36, 38 in a central region of the dielectric layer 44, 48 away from the corner regions of the dielectric layers 44, 48, which destroys uniformity of resistance across the dielectric layer 44, 48.

In addition, *Shiue* describes dielectric layers 44, 48 having via plugs 36, 38 formed in a diamond pattern and inserted through the dielectric layers 44, 48. However, *Shiue* does not teach or suggest that there are open spaces or gaps between portions of the dielectric layers 44, 48, which are required to create protrusion in the dielectric layer, as defined by Claims 1 and 8. Thus, *Shiue* does not teach or suggest protrusions in the dielectric layers, but rather a

dielectric layer perforated by via plugs, in which the via plugs are completely surrounded by the dielectric layer.

In contrast, as shown in Figure 12, the subject invention teaches protrusions 20 separated by gaps in the pad trench 18. The effect on resistance of the protrusions is effectively compensated for by locating the contact holes 26 near the protrusions 20, as now defined by amended Claims 1 and 8.

Applicants respectfully note that in order to support a claim of *prima facie* obviousness, the cited references must teach or suggest each and every element of the invention and there must be a motivation in the references or the prior art to combine the references as suggest. However, none of the art of record teaches or suggests, either alone or in combination, a damascene interconnection, which includes a protrusion formed by a portion not removed of an insulating film in a pad trench, and a contact hole formed within the pad trench at a position near the protrusion to electrically connect a conductive film to a further conductive film formed below an insulating film, wherein the contact hole and the further conductive film suppress an increase in electrical resistance in the pad trench due to formation of the protrusion, as now defined by amended Claims 1 and 8.

Applicants respectfully submit that Claims 2-6 and 15, which ultimately depend from Claim 1, and Claims 9-13 and 16, which ultimately depend from Claim 8, are patentable over the art of record by virtue of their dependence from Claims 1 and 8, respectfully, which are believed patentable for the reasons set forth above. Further, Applicants submit that Claims 2-6, 9-13, 15, and 16 define additional patentable subject matter in their own right. Therefore, it is respectfully requested that the rejection of Claims 1-6 and 8-13 under 35 U.S.C. §103(a) be reconsidered and withdrawn.

In view of the foregoing Amendment and remarks, entry of new Claims 15 and 16 and the amendments to Claims 1 and 8; favorable consideration of new Claims 15 and 16 and the

amendments to Claims 1 and 8; favorable reconsideration of Claims 2-6 and 9-13; and allowance of pending Claims 1-6, 8-13, 15, and 16 are respectfully and earnestly solicited.

Respectfully submitted,

Rod S. Turner
Registration No. 38,639
Attorney for Applicant(s)

Hoffmann & Baron, LLP
6900 Jericho Turnpike
Syosset, NY 11791
(516) 822-3550
RST:mak

VERSION OF AMENDMENT WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Please amend Claims 1 and 8 by rewriting the same as follows:

1. (Twice Amended) A damascene interconnection comprising:

an interconnection trench formed in an insulating film and a pad trench communicating therewith;

a protrusion formed by a portion not removed of said insulating film in said pad trench to decrease a substantial opening area of said pad trench;

a conductive film buried in said interconnection trench and said pad trench; and

a contact hole formed within said pad trench at a position near said protrusion to electrically connect said conductive film to a further conductive film formed below said insulating film, wherein said contact hole and said further conductive film substantially suppress an increase in electrical resistance in said pad trench due to formation of said protrusion.

8. (Three Times Amended) A semiconductor device, comprising:

a semiconductor substrate;

an insulating film formed on said semiconductor substrate;

an interconnection trench formed on said insulating film and communicating with a semiconductor element;

a pad trench formed on said insulating film and communicating with said interconnection trench;

a protrusion formed by a portion not removed of said insulating film in said pad trench and reducing a substantial opening area of said pad trench;

a conductive film buried in said interconnection trench and said pad trench;

a further conductive film formed below said insulating film; and

a contact hole formed within said pad trench at least at a position near said protrusion to electrically connect said conductive film to said further conductive film, wherein said contact hole and said further conductive film substantially suppress an increase in electrical resistance in said pad trench due to formation of said protrusion.

Please add new Claims 15 and 16.

--15. (New Claim) A damascene interconnection according to claim 1, wherein said hole is located to surround said protrusion.

16. (New Claim) A semiconductor device according to claim 8, wherein said hole is located to surround said protrusion.--